Water Wheel Motor

FIELD OF THE INVENTION

The technical solution refers to the equipment for change of hydro-energetic potential of water flow to mechanical energy with the possibility of further transformation of the energy into another form.

BACKGROUND OF THE INVENTION

At the present, there are many types of equipment used in the world for transformation of hydro-energetic potential of water flow to mechanical energy, with the possibility to transform this energy into another form. According to their design and method of energy transformation, they are divided into water wheels and water turbines.

Water wheels are actuated by upper, middle and lower drive. Water wheels with upper drive use the potential energy of water. They are of the bucket type of water wheels, rotating between an upper and lower water level. Water from the upper level flows into buckets and turns a wheel by gravitational force. Water flows out into the lower level. For water wheels with upper drive, a water level difference from 3 m to 12 m produces a water flow rate from 0.3 m^3s^{-1} to 1.0 m^3s^{-1}.

Water wheels with middle and lower drive are paddle type water wheels, with a rotation axis above the lower level, and water wheel paddles take energy from the water by wading in a lower flow created by streaming water coming from the upper level. A water wheel with a middle drive uses the potential energy and the kinetic energy of water streaming between the water wheel paddles approximately at the level of the water wheel rotation axis. Examples of water wheels with a middle drive include Sagebien, Zuppinger and Piccard wheels. Water wheels with lower drive use only the kinetic energy of water flowing between the water wheel paddles in the tangential direction at the lower part of the water wheel. An example of a water wheel with lower drive is the Poncelet wheel.

Water wheel paddles are plane or slightly bent in the plane perpendicular to the water wheel rotation axis. For water wheels with middle and lower drive, a difference

between water levels from 0.5 m to 4.0 m produces flow rates from 0.5 m^3s^{-1} to 4.0 m^3s^{-1}. The efficiency of all water wheels is between 60% to 70%. The advantage of water wheels is their simple design and low price. Their disadvantage is their low efficiency and small range of operating conditions. The low efficiency is caused by paddle shape, and their resistance, by wading in water. The small range of operation conditions results from the relation between water wheel dimensions and the difference between water levels.

Water turbines are classified, according to the water energy type they use, as isobaric or overpressure type, and, according to the turbine water flow direction, as radial, axial, radial-axial, diagonal, or tangential, with oblique flow or double flow. The isobaric turbines, such as Pelton and Banki turbines, use water kinetic energy.

The Pelton turbine is of the tangential type. Water is supplied via a pressure pipe with a nozzle on its end, where its pressure energy is transformed into kinetic energy and a stream of water is sprayed in a tangential direction on the space shaped turbine paddles along a turbine rotor circumference. The turbine rotor rotates in the air above the lower water level. The rotation axis can be horizontal or vertical. A difference between water levels from 30 m to 900 m produces flow rates from 0.02 m^3s^{-1} to 1.0 m^3s^{-1}. This turbine has an efficiency of up to 91%.

The Banki turbine, with double radial flow through the paddle wheel, has a horizontal rotation axis. The wheel paddles take the kinetic energy from water streaming out of a regulation flap located immediately above the turbine wheel. For the Banki turbine, a difference between water levels from 1.5 m to 50 m produces flow rates from 0.02 m^3s^{-1} to 1.5 m^3s^{-1}. This turbine has an efficiency of up to 85%.

Examples of water overpressure turbines include Kaplan turbines, Francisci turbines, and their different modifications, for example, so-called propeller or suction turbines.

The Kaplan turbine is of the axial type. For a difference between water levels from 1.5 m to 75 m, the Kaplan turbine produces flow rates from 0.2 m^3s^{-1} to 20 m^3s^{-1}. The efficiency of the Kaplan turbine is 88% to 95%.

The Francis turbine is of the radial-axial type. For a difference between water levels from 10 m to 400 m, the Francis turbine produces flow rates from 0.05 m^3s^{-1} to 15 m^3s^{-1}. The efficiency of the Francis turbine is 88% to 95%.

The advantages of water turbines are a big range of operation conditions and higher efficiency. Their disadvantages are the complicated equipment and high price.

Description of the invention

In the proposed technical solution, the advantages of water wheels, such as simple design and low price, are combined with the advantages of water turbines. The water wheel motor, for energetic use of hydro-energetic potential of the water flow, consists of an outlet device, a drain device, a wheel and isobaric paddles fixed to the wheel, which can rotate around the wheel's rotation axis.

The wheel, with fixed isobaric paddles, rotates around its rotation axis and has such a position, in relation to the drain device, that all paddle points are at or above a first plane, which is at or lower than and parallel to a second plane limiting the drain device space containing water.

The rotation axis of the wheel with isobaric paddles can be vertical, horizontal or oblique.

The outlet device, thanks to its shape and position of its axis in relation to the isobaric paddle wheel, guides the water stream, created by the hydro-energetic water potential, to the isobaric paddles fixed to the wheel.

The isobaric paddles take kinetic energy from water streaming on them and exerting a force on them, and they change this energy to mechanical energy of the wheel's rotary movement. The isobaric paddles, due to their shape, size, position in relation to the water stream, direction, shape of their trajectory, and relative speed of their movement against the water stream, determine the transformation efficiency of kinetic water energy to mechanical energy.

The wheel design enables the further transport of its rotation movement energy, gained by means of the isobaric paddles from kinetic water energy, to other technical equipment.

The water stream, guided by the outlet device on the isobaric wheel paddles, falls from the isobaric wheel paddles, after giving them its kinetic energy, to the water surface, which is at or lower than and parallel to the plane limiting the space of the drain device containing water, which is located below the wheel.

DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are described in detail below with reference to the attached drawing figures, wherein:

Fig.1 is a diagram of a water wheel motor according to one embodiment of the present invention;

Fig.2 is a small hydro-electric power plant with an inlet channel, a pressure shaft, and the water wheel motor of Fig. 1 with a horizontal rotation axis;

Fig.3 is the small hydro-electric power plant with the inlet channel, the pressure shaft and the water wheel motor of Fig. 1 with a vertical rotation axis;

Fig.4 is the small hydro-electric power plant with the inlet channel, a water slip and the water wheel motor of Fig. 1 with the horizontal rotation axis;

Fig.5 is the small hydro-electric power plant with a water level heaved by a steel damper and with four independent water wheel motors with the horizontal rotation axis according to one embodiment of the present invention;

Fig.6 is the small hydro-electric power plant on a weir of a water flow with the water wheel motor of Fig. 1 with the vertical rotation axis

Fig.7 is the small hydro-electric power plant on a heaved weir with the water wheel motor of Fig. 1 with the horizontal rotation axis;

Fig.8 is the small hydro-electric power plant on an overflow over the steel damper of the water flow with the water wheel motor of Fig. 1, with the horizontal rotation axis; and

Fig.9 is the small hydro-electric power plant and the water wheel motor of of Fig. 6 with an oblique rotation axis.

EXAMPLES

One embodiment of the present invention, illustrated in Fig. 2, is a small hydro-electric power plant of micro plants category, with a level difference of 2.8 m, a flow rate of 0.125 m^3s^{-1} to 1.0 m^3s^{-1}, and an installed capacity of 22 kW. The equipment in Fig. 2 consists of an upper water level inlet channel 3, a pressure shaft 12, a regulating outlet device 1, a regulator 11, which may be a floater regulator, as in Fig. 2, or a manual

regulator, of the outlet device 1, isobaric paddles 4 fixed on a wheel 5 with a rotation axis 18 which may be horizontal, as in Fig. 2, vertical, or oblique, a drain device 6, a transmission 7 which may be a friction transmission, as in Fig. 2, a gearbox, or a belt transmission, a generator 8, an electric part 9 of a micro-electric power plant, and an equipment-carrying frame 10.

The inlet channel for the upper level 3 guides water into the pressure shaft 12, where the water, by water column hydrostatic pressure, sprays, via the outlet device, 1 in the direction of an axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates torque on the wheel 5 embedded on the horizontal rotation axis 18 in the equipment frame 10. The torque is transmitted from the wheel 5 via the friction transmission 7 to the generator 8. The water from the paddles 4 falls on the water surface, which is identical to a first plane 21, which is at or lower than a second plane 19 and is parallel to the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of the generator 8 into a public electricity network. The floater regulator 11 keeps, by regulating the outlet device 1, the upper water level 3 constant, disregarding the water supply in the inlet channel.

Another embodiment of the present invention, illustrated in Fig. 3, is a small hydro-electric power plant of micro plant category, with a level difference of 2.0 m, a flow rate of 0.25 m^3s^{-1} to 2.0 m^3s^{-1}, and an installed capacity of 30 kW. The equipment in Fig.3 consists of the upper water level inlet channel 3, the pressure shaft 12, the regulating outlet device 1, the regulator 11 of the outlet device 1, with an opto-electronic water level sensor, the isobaric paddles 4 fixed on the wheel 5 with the vertical rotation axis 18, the drain device 6, the friction transmission 7, the generator 8, the electric part 9 of the micro-electric power plant, and the equipment-carrying frame 10.

The inlet channel for the upper level 3 guides water into the pressure shaft 12, where the water, by water column hydrostatic pressure, sprays, via outlet device 1, in the direction of the axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates the torque on the wheel 5 embedded on the vertical rotation axis 18 in the equipment frame 10. The torque is transmitted from the wheel 5 via gearbox 7 to the generator 8. The water from the paddles 4 falls on the water surface, which is identical to

the first plane 21, which is at or lower than the second plane 19 and is parallel with the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of the generator 8 into the public electricity network. The regulator 11 of the outlet device 1 with the opto-electronic water level sensor keeps, by regulating the outlet device 1, the upper water level 3 constant, disregarding the water supply in the inlet channel.

Another embodiment of the present invention, illustrated in Fig. 4, is a small hydro-electric power plant of micro plant category, with a level difference of 14.0 m, a flow rate of 0.035 m^3s^{-1} to 0.28 m^3s^{-1}, and an installed capacity of 37 kW. The equipment is designed with respect to the high water speed achieved in the outlet and directed onto the wheel so that the wheel revolutions are identical with required revolutions for the generator and speed change is unnecessary. The equipment in Fig. 4 consists of the upper water level inlet channel 3, a water slip 15, the outlet device 1, the isobaric paddles 4 fixed on the wheel 5 with the horizontal rotation axis 18, the drain device 6, the generator 8, the electric part 9 of the micro-electric power plant, a carrying structure of a channel 13, and the equipment-carrying frame 10.

The inlet channel for the upper level 3 guides water to the water slip 15, where the water's energetic potential, by gravitational force, is changed into kinetic energy, which makes the water spray, via the outlet device 1, in the direction of the axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates torque on the wheel 5 embedded on the horizontal rotation axis 18 in the equipment frame 10. The torque is transmitted from the wheel 5 directly to the generator 8. The water from the paddles 4 falls on the water surface, which is identical to the first plane 21, which is at or lower than the second plane 19 and is parallel to the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of the generator 8 into the public electricity network.

Another embodiment of the present invention, illustrated in Fig. 5, is a small hydro-electric power plant with a level difference of 4.2 m, a flow rate of 0.375 m^3s^{-1} to 12.0 m^3s^{-1} and an installed capacity of 380 kW. The equipment in Fig. 5 consists of a flow

heaving dam to the upper level 3, four outlet devices 1, the outlet device regulator 11 with an opto-electronic water level sensor, four wheels 5 with fixed isobaric paddles 4 and the horizontal rotation axis 18, the drain device 6, four friction transmissions 7a, four gearboxes 7b, four generators 8, the electric part 9 of the micro-electric power plant, and the equipment-carrying frame 10.

The hydrostatic pressure of the water column, created by heaving the upper water level 3, sprays the water, via the outlet devices 1, in the direction of the axis 2 of the outlet devices 1, on the isobaric paddles 4 of the wheels 5, which creates torque on the wheels 5 embedded on the horizontal rotation axis 18 in the equipment-carrying frame 10. The torque is transmitted from the wheels 5 via the friction transmission 7a and gearboxes 7b to the generators 8. The water from the paddles 4 falls on the water surface, which is identical to the first plane 21, which is at or lower than the second plane 19 and is parallel to the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of generators 8 into the public electricity network. The regulator 11 of the outlet devices 1 with the opto-electronic water level sensor keeps, by regulating the outlet devices 1, the upper water level 3 constant, disregarding the water supply to the flow heaving dam.

Another embodiment of the present invention, illustrated in Fig. 6, is a small hydro-electric power plant on a weir with a level difference of 3.1 m, a flow rate of 0.06 m^3s^{-1} to 0.5 m^3s^{-1}, and an installed capacity of 11 kW. The equipment in Fig. 4 consists of the inlet water slip 15, the outlet device 1, isobaric paddles 4 fixed on the wheel 5 with the vertical rotation axis 18, the drain device 6, the gearbox 7, the generator 8, the electric part 9 of the micro-electric power plant, and the equipment-carrying frame 10.

The weir heaves the upper water level 3 and water runs over an upper edge of the weir where the hydro-energetic potential of water falling in the water slip 15 is changed, by gravitational force, into kinetic energy, which makes the water spray, via the outlet device 1, in the direction of the axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates torque on the wheel 5 embedded on the vertical rotation axis 18 in the equipment-carrying frame 10. The torque is transmitted from the wheel 5 via the gearbox 7 to the generator 8. The water from the paddles 4 falls on the water surface,

which is identical to the first plane 21, which is at or lower than the second plane 19 and is parallel to the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of generator 8 into the public electricity network.

Another embodiment of the present invention, illustrated in Fig. 7, is irrigation equipment for flowing with a level difference of 2.2 m, a flow rate of 2.2 m^3s^{-1}, a discharge height of 30 m, and a capacity of 100 ltrs/s. The equipment in Fig. 7 consists of the pressure shaft 12, the outlet device 1 with the manual regulator 11 of the outlet device 1, isobaric paddles 4 fixed on the wheel 5 with the horizontal rotation axis 18, the drain device 6, a water centrifugal pump 16 with the gearbox 7, a suction pipe with a strainer 17, a discharge pipe 14, and an equipment-carrying frame 10.

The flowing heaves the upper water level 3, connected with the pressure shaft 12, where the water, by water column hydrostatic pressure, sprays, via outlet device 1, in the direction of the axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates torque on the wheel 5 embedded on the horizontal rotation axis 18 in the equipment-carrying frame 10. The torque is transmitted via the gearbox 7 from the wheel 5 on the centrifugal water pump 16, which sucks water from the heaved water level space via the suction pipe with the strainer 17 and discharges it via the discharge pipe 14 into the agricultural irrigation system. The water from the paddles 4 falls on the water surface, which is identical to the first plane 21, which is at or lower than the second plane 19 and is parallel with the second plane 19 limiting the upper level of the water-containing drain device 6. The equipment output is controlled by the manual regulator 11 of the outlet device 1.

Another embodiment of the present invention, illustrated in Fig. 8, is a micro hydro-electric power plant on a weir with a level difference of 3.0 m, a flow rate of 0.125 m^3s^{-1} to 1.0 m^3s^{-1} and an installed capacity of 22.5 kW. The equipment in Fig. 8 consists of the water stream guide functioning as the outlet device 1, isobaric paddles 4 fixed on the wheel 5 with the horizontal rotation axis 18, the drain device 6, a belt transmission 7, the generator 8, the electric part 9 of the micro-electric power plant and the movable equipment-carrying frame 10.

The weir heaves the upper water level 3 and water runs over the upper edge of the

weir where the falling water hydro-energetic potential is changed into kinetic energy, which makes the water spray, via a water stream guide, fulfilling the function of the outlet device 1, in the direction of the axis 2 of the outlet device 1, on the isobaric paddles 4 of the wheel 5, which creates torque on the wheel 5 embedded on the horizontal rotation axis 18 in the movable equipment-carrying frame 10. The torque is transmitted from the wheel 5 via the belt transmission 7 to the generator 8. The water from the paddles 4 falls on the water surface, which is identical to the first plane 21, which is at or lower than the second plane 19 and is parallel to the second plane 19 limiting the upper level of the water-containing drain device 6. The electric part 9 of the micro electric power plant ensures the technical parameters required for connection of the generator 8 into the public electricity network. The mechanical linkage of the movable equipment-carrying frame 10 with ~~the~~ a damper ensures their mutual position so that the falling water is directed into the stream guide, fulfilling the function of outlet device 1, regardless of the position of the damper.

INDUSTRIAL UTILITY

The proposed technical solution, water wheel motor, can be used for mechanical drive of on-site equipment where hydro-energetic potential, in the range of required operation conditions, is available.